The Energy Independence and Security Act

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Introduction: U.S. Oil Facts

- The U.S. consumes 25% of world oil, 20 million barrels per day (mbd), but holds only 3% of known reserves.
- The average fuel economy in the U.S. is only 20.2 mpg, less than in 1987, and lower than the EU, China, and Japan.
- Light duty vehicles account for 40% of all U.S. oil consumption, and 20% of U.S. CO_2 emissions.
- 248 million light duty vehicles are expected to consume 139 billion gallons of gasoline in 2008, at a cost of nearly $500 billion.

High Oil Prices Spur Public Awareness

- President Bush State of the Union Address included a call for “20 in 10”: reducing oil consumption by 20% in 10 years.
- Low Carbon Economy Act of 2007 (“Bingman-Spector”) – places a cap on greenhouse gas emissions, establishing a market for allowances. (hasn’t passed)
- Climate Security Act of 2008 (“Warner-Lieberman”) – aims to reduce greenhouse gas emissions through a system of traded allowances. (hasn’t passed)
- Energy Independence and Security Act of 2007 (“EISA”) – Aims to reduce oil dependence through alternative fuels and mileage standards. (passed December 2007)

➢ **Greenhouse gas reductions are still difficult to pass in the U.S., but reducing oil dependence is popular.**

Provisions of EISA 2007

- Corporate Average Fuel Economy (CAFE) – New target of 35 mpg of new light duty fleet by 2020. New standards begin to take effect in 2011.

- Renewable Fuels Standard (RFS) – Requirements for biofuels blending into gasoline, starting at 9 billion gallons in 2008 and 36 billion gallons by 2022. Of the latter, 15 is from corn ethanol, and 21 from advanced biofuels, including cellulosic ethanol.
- Energy Efficiency Equipment Standards – A variety of new standards for lighting and residential and commercial appliances.
- Repeal of Oil and Gas Tax Incentives – Two tax subsideies to the oil and gas industries are repealed to offset estimated costs of CAFE.

Modeling Strategy

- Two scenarios developed: business as usual (BAU) and EISA.
- EISA scenario was calibrated to the Department of Energy *Annual Energy Outlook (AEO)* for macroeconomic and energy variables.
- We assumed less ethanol production than called for in the RFS.
- BAU case has much slower expansion of ethanol and CAFE, but still some increase from the current level.
- Oil prices for both cases are the same, falling from their current level in real terms, and then rising again after 2015. (This is the AEO assumption.)

Advantages of LIFT for This Study

- LIFT includes an input-output model as its core. By changing the IO coefficients:
  - LIFT can explicitly model the relationship between Agriculture and Chemicals (in ethanol production) and between Chemicals and Petroleum refining (in ethanol blending).
  - LIFT models the substitution of ethanol for petroleum-based gasoline.
- LIFT models the interaction of industry-specific effects with the macroeconomy. For example, what are the macroeconomic impacts of higher Agriculture or Motor vehicle prices?
- LIFT can be extended with Interdyme tools (IdBuild) to build submodules relating to agriculture, ethanol and motor vehicles.

Calibration to *Annual Energy Outlook*

- The EISA case was developed first, even though it is the "alternative" simulation.
- It was calibrated to the 2008 Annual Energy Outlook, which includes the impacts of the EISA in its projections to 2030.
- Although Inforum produces a baseline LIFT forecast to 2030, for this exercise we controlled LIFT to agree with the AEO for the following macroeconomic variables:
  - Real components of GDP.
  - Population, labor force and productivity growth.
  - Nominal GDP and inflation.
  - Energy prices and interest rates.
- Through IO coefficient fixes, we also calibrated LIFT to agree with the AEO forecasts of residential, commercial, industrial and transportation energy demand, by type of energy (coal, natural gas, petroleum refining, electricity).

Ethanol Modeling

- An Ethanol submodule for LIFT was developed to show ethanol feedstock (corn or cellulose) use, other input requirements, equipment investment, production, and cost.
- From the ethanol module, fixes are developed for sectoral variables (chemicals investment) and IO coefficients (Agriculture into Chemicals)
- Projections for corn supply and use were also developed to show corn ethanol production in context.

Ethanol Assumptions

	2008	2010	2020	2030
Corn Ethanol Production (billions of gallons)				
Without the EISA	8.6	12.0	14.8	15.0
With the EISA	8.6	12.0	19.3	20.0
Cellulosic Ethanol Production (billions of gallons)				
Without the EISA	0.0	0.0	1.2	2.1
With the EISA	0.0	0.0	1.2	12.0
Total Ethanol Production (billions of gallons)				
Without the EISA	8.6	12.0	16.0	17.1
With the EISA	8.6	12.0	20.5	32.0

- Although the RFS mandates 36 billion gallons of ethanol by 2022, we assumed the total ethanol production only reaches 32 billion gallons by 2030 in the EISA case. We assume an increase to 17.1 billion gallons in the base case. The biggest difference due to the EISA is expected to be in cellulosic ethanol.

Ethanol Capacity and Investment

	2008	2010	2020	2030
Corn Ethanol Production Capacity				
Annual Production Capacity (billions of gallons)	9.8	12.6	17.4	18.2
	9.8	14.0	22.1	24.0
Incremental Capital Cost (2007$ per gallon of capacity)	1.45	1.35	1.30	1.30
Investment (Millions of 2007$)	6244.6	1674.0	520.0	0.0
	6244.6	3041.6	881.4	117.0
Cellulosic Ethanol Production Capacity				
Annual Production Capacity (billions of gallons)	0.0	0.0	1.5	2.8
	0	0	1.5	12.9
Incremental Capital Cost (2007$ per gallon of capacity)	7.2	6.5	4.7	3.0
Investment (Millions of 2007$)	0.0	0.0	2180.2	0.0
	0.0	0.0	2180.2	2235.0

- Capacity is expected to be higher than actual production, to maintain an 85% capacity utilization rate.
- Investment requirements are assumed to fall to $1.30 per gallon of capacity for corn, and $3.00 per gallon of capacity for cellulosic ethanol, by 2030. (A 100 million gallon cellulosic plant is assumed to cost $300 million to build.)
- The required investment difference is used as an add factor (“cta” fix) in LIFT.

The Corn Market

- Total corn production is assumed to be the same in both scenarios, reaching 16.1 billion bushels by 2030.
- Corn ethanol will require 4.8 billion bushels in the base case, and 6.5 billion in the EISA case.
- We assume that exports and feed use must be reduced to make room for corn ethanol production.
- In either scenario, the share of corn for ethanol is high: 30.1% in the base case, and 40.1% in the alternate case, by 2030.

Corn Supply & Disposition (billions of bushels)

	2008	2010	2020	2030
Production	11.9	13.6	15.2	16.1
	11.9	13.6	15.2	16.1
Feed and Residual	5.4	5.1	5.5	6.5
	5.4	5.1	4.7	5.8
Food, Seed & Industrial	5.5	6.6	7.5	7.3
	5.5	6.6	9.0	9.0
Ethanol	3.0	4.1	5.0	4.8
	3.0	4.1	6.5	6.5
Non-Ethanol FS&I	2.5	2.5	2.5	2.5
	2.5	2.5	2.5	2.5
Domestic Use	10.9	11.7	12.9	13.8
	10.9	11.7	13.7	14.7
Exports	2.2	1.7	2.1	2.6
	2.2	1.7	1.3	1.9
Share of Corn for Ethanol (percent)	24.9	30.0	32.6	30.1
	24.9	30.0	42.5	40.1

IO Coefficient Modifications for Ethanol

- Corn and cellulosic biomass are both in Agriculture, forestry and fisheries (industry 1). Ethanol is part of Other chemicals (23). Flows of corn and biomass were converted to constant dollars, and the IO coefficient A(1,23) was recalculated to reflect these flows.
- The ethanol blended into gasoline in Petroleum refining (24) resulted in an increased IO coefficient A(23,24).
- Crude petroleum (5) displaced by ethanol was calculated and converted to constant dollars, and the input requirements for Crude petroleum into refining were adjusted by reducing A(5,24).
- The results of these changes are increased Agriculture demand, increased Other chemicals demand, and reduced demand for Crude petroleum. All of these changes were shared between domestic output and imports depending on the behavior of the import equation or exogenously specified import share.

Corn and Agriculture Price Effects

		2012	2020	2030
Corn Production for Ethanol (bil bu)	BAU	4.5	5.0	4.8
	EISA	4.5	6.5	6.5
	Difference	0.0	1.5	1.6
Total Corn Production (bil bu)		13.6	15.2	16.1
Ethanol Demand Shift (percent of total)		0.0%	9.9%	10.0%
Assumed corn price multiplier	**2.8**			
Percentage increase in corn and soy prices		0.0%	27.8%	28.1%
Corn and soybeans share of Agriculture	**12%**			
Increase in Agriculture price		0	3.2%	3.3%

- Corn ethanol demand shifts demand up by 1.6 billion bushels, or 10% of total supply, by 2030.
- The US Dept. of Agriculture suggests that both corn and soy should respond with a 2.8 multiplier of price with respect to increases in corn demand. This implies a 28% increase in corn and soy prices in 2030.
- Since corn and soybeans make up about 12% of total US agriculture, this results in a 3.3% increase in agriculture prices.

Vehicle Fuel Consumption

	2008	2010	2020	2030
Light-duty Vehicles, Total				
Miles Per Gallon	20.9	21.3	22.5	23.3
	20.9	21.4	26.2	30.0
Fuel Consumption (GEG)	138.8	141.1	160.5	180.7
	138.6	139.3	135.6	138.7
Gasoline Summary (mil gal)				
Ethanol Supply (includes imports)	9.4	12.9	19.2	24.1
	9.4	12.9	23.7	39.0
Gasoline Replaced by Ethanol	6.2	8.5	12.7	15.9
	6.2	8.5	15.6	25.7
Petroleum Based Gasoline	132.6	132.6	147.8	164.8
	132.4	130.8	120.0	113.1

- CAFE standards apply only to the fleet of new vehicles sold. Approximately 7% of the total fleet is new each year. Average light duty vehicle mpg is expected to reach only 23.3 in the base, and 30 in the EISA case, by 2030.
- The extra efficiency in the EISA case allows total consumption to remain roughly flat, or about 42 billion gallons less than the base case by 2030.
- Each gallon of gasoline requires 1.5 gallons of ethanol to replace it. Gasoline replaced by 39 billion gallons of ethanol is roughly 26 billion gallons. The total reduction in petroleum based gasoline is about 52 billion gallons.

Motor Vehicle Input Assumptions

- In order to achieve increases in fuel efficiency for Motor vehicles, increased input requirements were assumed. Motor vehicle input coefficients from the following industries were increased:
  - Plastic products – Required for reducing vehicle weight.
  - Engines and turbines – Hybrids and advanced internal combustion (IC) require more expensive engines.
  - Electrical industrial apparatus – This includes electric motors and batteries for hybrids and plug-in electric vehicles.
  - Electronic components – Hybrids, plug-ins and advanced IC require more semiconductors and other computer components.
  - Motor vehicle parts – Higher quality and more costly components required for dozens of technology improvements.
  - Other instruments – Increased use of monitoring and control instruments for IC.
  - Professional services – Increased R&D and design services.
- These coefficient changes resulted in an increase in the price index for Motor vehicles of 17% by 2030.

Simulation Results: Macroeconomic Summary

	2008	2010	2020	2030
REAL GDP by FINAL DEMAND CATEGORY				
(Billions of chained 2000 dollars)				
Gross Domestic Product	11650	12361	15936	20439
	-14	-45	-97	-180
Personal Consumption Expenditures	8392	8860	11403	14080
	-12	-41	-97	-122
Gross Private Fixed Investment	1716	1929	2598	3665
	-2	-7	0	-23
Exports	1518	1764	3408	6050
	0	0	-16	-66
Imports	2017	2233	3536	5286
	0	-3	-13	-8
Government	2078	2103	2283	2504
	0	-1	-2	-1
GDP Deflator	122.3	126.8	152.5	185.9
	0.0	0.0	0.9	2.8
Unemployment Rate	5.8	5.9	4.5	5.9
	0.1	0.3	0.3	0.3
Real Disposable Income, bil 00$	8765	9220	11977	14922
	-13	-44	-100	-116
Trade Balance	-833	-824	-943	-748
	-1	3	30	55
Oil Imports	98.7	90.7	90.5	101.8
	0.0	0.1	-4.7	-13.8

Simulation Results: Commodity Output

	2008	2010	2020	2030
Output (billions of constant 2000$)				
1 Agriculture, forestry and fisheries	397.6	416.3	495.0	562.4
	-0.2	-0.5	0.2	4.8
5 Crude petroleum	81.4	89.3	88.6	68.7
	0.0	0.1	-3.9	-7.3
23 Other chemicals	246.3	263.4	332.0	392.4
	-0.1	-0.3	4.2	11.8
24 Petroleum refining	259.8	259.3	270.8	278.5
	0.1	0.5	-5.7	-8.9
25 Fuel oil	74.9	75.2	82.0	91.7
	0.0	-0.2	-2.2	-3.6
27 Plastic products	153.3	163.5	215.1	288.6
	-0.1	0.2	6.7	16.0
43 Electrical industrial apparatus	33.2	34.5	38.9	47.4
	0.0	0.1	0.9	1.0
48 Electronic components	221.7	241.8	343.4	468.9
	-0.1	0.0	3.4	6.6
49 Motor vehicles	292.6	314.7	397.1	499.0
	-0.4	-1.8	-6.2	-15.6
57 Other instruments	86.2	96.5	146.7	229.6
	-0.1	0.1	1.4	2.7
63 Pipelines	8.0	8.1	9.5	11.5
	0.0	0.0	-0.3	-0.4

Simulation Results: Employment

	2008	2010	2020	2030
Employment (thousands)				
1 Agriculture, forestry, and fisheries	3824.5	3832.3	3485.4	3000.6
	-1.2	-4.8	1.2	25.6
23 Other chemicals	441.9	460.6	467.8	428.6
	-0.1	-0.4	5.9	12.8
24 Petroleum refining & fuel oil	106.6	97.8	70.3	49.6
	0.0	0.1	-1.5	-1.7
27 Plastic products	629.2	608.3	522.0	468.6
	-0.2	0.0	15.6	25.5
43 Electrical industrial apparatus	156.0	146.9	104.0	85.1
	0.0	0.1	2.5	1.8
48 Electronic components	535.6	397.9	213.1	233.9
	-0.3	-0.1	3.4	3.6
49 Motor vehicles	474.0	493.2	549.3	580.0
	-0.4	-2.2	-8.1	-17.8
57 Other instruments	255.6	277.4	308.4	329.4
	-0.1	0.1	3.0	4.2
63 Pipelines	9.6	9.1	8.1	7.7
	0.0	0.0	-0.2	-0.3
Total Employment	148166.4	151245.5	162126.2	171798.5
	-127.1	-432.7	-465.7	-493.7

Conclusions